
PACIFIC MISSILE RANGE FACILITY COMBINED HEAT AND POWER FEASIBILITY STUDY

FINAL REPORT

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- A Interim Report on Task 1
- B Interim Report on Task 2: Energy Baseline Evaluation and CHP Economic and Engineering Options
- C Interim Report on Task 3: Findings and Recommendations on the Economic Evaluation of Alternatives
- D Interim Report on Task 4: Final Economic and Strategic Feasibility Study

SECTION 1

EXECUTIVE SUMMARY

The purpose of the Pacific Missile Range Facility Combined Heat and Power Feasibility Study was to evaluate the feasibility of developing a combined heat and power (CHP) plant, at the Pacific Missile Range Facility (PMRF), utilizing landfill gas from the Kekaha Landfill. The Kekaha Landfill is owned by the County of Kauai.

SCS Energy (SCS) collected samples of landfill gas from the closed Phase I section of the Kekaha Landfill and analyzed data from a previous sampling effort of the open Phase II section of the Kekaha Landfill. SCS concluded that the landfill gas at Kekaha Landfill was suitable for use as a fuel for a CHP project. SCS prepared a 25-year projection of recoverable landfill gas, which indicated that the recoverable landfill gas could support 1.6 MW of electric power generation.

SCS prepared a conceptual design and cost estimate for a landfill gas collection system for the Kekaha Landfill, for a landfill gas compression and moisture removal facility at the Kekaha Landfill, and for a landfill gas transmission pipeline between the Kekaha Landfill and the existing PMRF power plant. The pipeline would be about 3.9 miles in length and would employ below-ground, 6-inch diameter, high density polyethylene (HDPE) pipe.

A review of PMRF's electric power consumption and production, thermal energy requirements (chilled water and hot water), fuel consumption (diesel oil and propane), and energy costs was undertaken. A review of PMRF's electric power production equipment, chilled water production equipment and hot water production equipment was also undertaken. The on-site electric power distribution system was evaluated. Technical alternatives for CHP were identified and discussed.

Six alternatives were configured based on SCS's findings from the above work. The alternatives were as follows:

Alternative No. 1-A: Fuel the existing engines on diesel oil, with the addition of heat recovery, and retain the current program of intermittent operation;

Alternative No.1-B: Fuel the existing engines on diesel oil, with the addition of heat recovery, and convert to full-time operation;

Alternative No. 2-A: New landfill gas fired reciprocating engines at the existing PMRF power plant with heat recovery to produce chilled water with an absorption chiller, plus a microturbine with absorption chiller at Building 1262;

Alternative No.2-B: New landfill gas fired reciprocating engines at the existing PMRF power plant with heat recovery to produce chilled water with an absorption chiller, without a microturbine at Building 1262;

Alternative No.3: New landfill gas fired reciprocating engines on PMRF grounds close to the landfill; and

Alternative No. 4: New landfill gas fired reciprocating engines at the landfill.

The above-identified six alternatives were compared on the basis of life cycle energy cost reduction, fossil fuel consumption reduction, and quantity of renewable power generated. Alternative No. 2-B was selected as the preferred alternative.

The principal components of Alternative No. 2-B are as follows:

- Installation of a landfill gas collection system at the Kekaha Landfill. The landfill gas collection system will consist of 39 landfill gas extraction wells, and related piping, as is more fully described in Section 5 of the Interim Report on Task 1;
- Installation of a landfill gas processing skid at the landfill. It will have a design capacity of 600 scfm and an operating pressure of 25 psig. It will chill the landfill gas to 45° F and reheat it to 65° F prior to introduction into the pipeline. A tentative location for the skid is shown on Figure No. 5-2 in Section 5 of the Interim Report on Task 1;
- A 3.9-mile, 6-inch diameter, landfill gas transmission pipeline from the landfill to the site of the existing PMRF power plant. The general alignment of the pipeline is shown on Figure No. 6-1 in Section 6 of the Interim Report on Task 1;
- A 1,640 kW landfill gas fired CHP plant, located adjacent to the existing PMRF power plant. The CHP plant will employ two 820 kW reciprocating engines, and engine appurtenant equipment, heat recovery equipment, and an absorption chiller. Table No. 2-1 in Section 2 of the Interim Report on Task 4 provides a summary of the major equipment that will be employed at the CHP plant. The CHP plant would interconnect into the PMRF power distribution system at the existing PMRF power plant;
- Chilled water delivery equipment and piping to supply chilled water to Buildings 130, 105 and 105ROCS. The existing cooling equipment would remain at these locations to provide supplemental and standby cooling; and
- A 12.47 kV electrical distribution line, about 13,800 feet in length, between the PMRF power plant and the Navy Housing area, to allow the Navy Housing area to receive power from the CHP plant. Implementation of this element of the project requires resolution of ownership issues for some of the power distribution lines in the Navy Housing area. These issues are discussed in Section 5 of the Interim Report on Task 4.

Additional information, descriptive of Alternative No. 2-B can be found in the Interim Report on Task 4.

The estimated cost of the proposed project is \$8,231,700. Based on assumptions and analyses contained in the Interim Report on Task 4, and under all scenarios evaluated, the investment in the project would have an internal rate of return in excess of 25 percent.

The largest unknown factors affecting the financial performance of the project, at this point, are the price to be paid to the County for its landfill gas and the standby power charge that Kauai Island Utility Cooperative (KIUC) will charge. KIUC has recently filed for approval to increase their standby power charge. The following matrix summarizes the impact on internal rate of return of alternative assumptions on landfill gas purchase price and standby power charge, as computed in Section 3 of the Interim Report on Task 4. The low standby power charge is KIUC's current charge. The high charge is KIUC's proposed charge. The medium charge is, for reasons explained in Section 2 of the Interim Report on Task 3, what SCS feels to be a more reasonable expectation for the charge that will ultimately be approved.

Landfill Gas Purchase Price	Standby Power Charge		
	Low \$5.00/kW	Medium \$10.45/kW	High \$37.47/kW
\$1.00/mmBtu	33.1%	31.8%	25.6%
\$2.00/mmBtu		30.2%	
\$3.00/mmBtu		28.5%	
\$4.00/mmBtu		26.8%	

The project will generate an average of almost 12 million kWh of renewable energy per year over its twenty-year life. It will reduce diesel oil consumption on Kauai by almost 800,000 gallons per year.

SECTION 2

SUMMARY OF CONTRACT DELIVERABLES BY TASK

SCS/County Contract Task 1 (County/DOE Contract Task 2)

Task 1 of the SCS/County contract is titled “Prepare a Gas Analysis and Recommendations for Gas Clean-up and Distribution.” The contract calls for the following work:

- a. The CONTRACTOR shall collect multiple samples of landfill gas (LFG) from the Kekaha Landfill Phase I (Phase I) passive LFG collection system of the Kekaha Landfill, using appropriate industry protocols, as required to ensure that the analyses specified herein are performed on representative LFG samples. The CONTRACTOR shall submit a sampling timeline/schedule for COUNTY approval before any work is performed so the Solid Waste Manager can coordinate ongoing landfill activities with the CONTRACTOR’s work. The County intends for LFG generated at Phase I to be sampled from the passive LFG collection system currently in place. CONTRACTOR shall conduct laboratory analysis of the LFG using appropriate test protocols to determine the following:
 1. Percent of concentration of carbon dioxide, nitrogen, oxygen, and methane;
 2. Types and percent concentration for Sulfides;
 3. Types and percent concentrations for Siloxanes;
 4. Types and percent concentrations of NMOC’s (non-methane organic compounds); and
 5. Types and percent concentrations of VOCs (volatile organic compounds);

The County of Kauai Solid Waste Division recently completed work to sample and analyze LFG from the active Kekaha Landfill Phase II (Phase II) area. Laboratory test results from samples collected from Phase II will be provided to the CONTRACTOR. The COUNTY intends for the sampling techniques and methodologies used in the Phase I sampling via this contract to mirror the techniques, methodologies and testing standards from the Phase II samplings so the results can be compared and evaluated. All tests shall follow generally accepted industry testing standards and protocols.

- b. The CONTRACTOR shall aggregate, compare and evaluate the results of the gas quality analyses tests with the previous testing conducted by the County of Kauai Solid Waste Division on Kekaha Landfill Phase II;

- c. The CONTRACTOR shall obtain existing data and update the information to include the County of Kauai Solid Waste Division's plans for an additional 15 foot vertical expansion and also a lateral expansion to Kekaha Landfill Phase II. Findings from the tests conducted under this contract and the prior Phase II tests will be used by the CONTRACTOR to prepare findings on the potential of gas production and availability (quality and quantity), and the cost of collection, cleanup, and distribution to the PMRF CHP plant;
- d. The CONTRACTOR shall prepare design recommendations and cost estimates for a distribution system from the Phase I and Phase II landfills' gas sources to the landfill property line and from the property line to PMRF end user. These recommendations shall also include any type of gas treatment needed and the recommended location of the treatment facility before the PMRF end user site;
- e. The CONTRACTOR shall identify the fair market value of the landfill gas to the County;
- f. The CONTRACTOR shall submit a draft report on Task 1 analyses, findings, cost estimates, fair market value and recommendations to the COUNTY for review and comment; and
- g. The CONTRACTOR shall submit, for COUNTY approval, a final report on Task 1 analyses, findings, cost estimates, fair market value and recommendations.

SCS satisfied its obligations under Task 1 and issued its "Interim Report on Task 1" in March 2006. A complete copy of that report can be found in Appendix A.

SCS/County Contract Task 2 (County/DOE Contract Task 3)

Task 2 of the SCS/County contract is titled "Develop PMRF Facility Energy Baseline Evaluation and CHP Economic and Engineering Options." The contract calls for the following work:

- a. The CONTRACTOR shall obtain and evaluate all existing PMRF energy data, electric and thermal load profiles, describe planned site modifications and expansions, inventory major equipment and replacement plans, obtain site layout drawings, develop a facility energy baseline, and provide an evaluation report for COUNTY review and approval;
- b. The CONTRACTOR shall develop economic and engineering options for a comprehensive and cost effective CHP Project, with consideration given to thermal requirements of the site, use of waste heat in an optimum manner for heating and cooling, power quality and reliability issues, load management,

- current utility rates, and maximized environmental benefit. Sensitivity analyses shall be developed as appropriate. Determination of the following shall be included, but not limited to, the optimal configuration of the system (type and size) for the quality and amount of gas that will be delivered; and the potential for sale of excess power to the local utility;
- c. The CONTRACTOR shall assess the specific economic and engineering feasibility of the following options:
- 1) Replacing the existing on-base power plant with a 24/7 CHP plant (type and size to be determined by the study) using petroleum-based fuel, propane, and/or methane gas options;
 - 2) Retrofitting the existing on-base power plant for 24/7 use and to use methane gas from the County of Kauai Solid Waste Division's adjacent landfill, with consideration given to modifying the existing on-base power plant, based on availability of methane gas production and to exhaust heat recovery systems that could be added to the existing on-base power plant;
 - 3) Constructing a back-up CHP plant of a type and size compatible with landfill gas production capability to run alternately with the existing on-base power plant;
 - 4) The CONTRACTOR shall submit the preliminary analysis and summary to the COUNTY for review and comments;
 - 5) Any other options determined by the Contractor to be viable, based on gathered data and analyses;
 - 6) Accounting for any interconnection equipment/standards that the Kauai Island Utility Cooperative might require; and
 - 7) Discussion shall also include the probable air emissions content from potential CHP technologies as it pertains to EPA and State Department of Health standards.
- d. The CONTRACTOR shall provide a written report for multi-agency technical review and COUNTY approval, in accordance with Task 2, herein, describing these options to COUNTY.

SCS satisfied its obligations under Task 2 and issued its "Interim Report on Task 2: Energy Baseline Evaluation and CHP Economic and Engineering Options," dated September 2006. A copy of that report can be found in Appendix B.

SCS/County Contract Task 3 (County/DOE Contract Task 4)

Task 3 of the SCS/County contract is titled “Prepare Findings and Recommendations.” The contract calls for the following work:

- a. The CONTRACTOR shall develop a site plan and present worth analysis for each option presented above based on industry engineering estimates. The analyses shall evaluate capital costs for each alternative along with installation, operation, maintenance and replacement costs over a 20-year life span, and present the results in present values. The analyses shall include predicted annual energy and cost savings in utility and operating costs reduction through the operation of each scenario;
- b. The CONTRACTOR shall make a written and oral report on the preliminary draft findings to the COUNTY for COUNTY approval; and
- c. The CONTRACTOR shall make a recommendation on the optimal system design to the Technical Review Committee and the COUNTY and shall move forward with the draft final report upon approval of the optimal system design by the COUNTY, with input from the Technical Review Committee.

SCS satisfied its obligations under Task 3 and issued its “Interim Report on Task 3: Findings and Recommendations on the Economic Evaluation of Alternatives,” dated November 2006. A copy of that report can be found in Appendix C.

SCS/County Contract Task 4 (County/DOE Contract Task 5)

Task 4 of the SCS/County contract is titled “Final Economic and Strategic Feasibility Study.” The contract calls for the following work:

- a. For the optimal system design scenario selected in Task 3c, the CONTRACTOR shall prepare an optimized configuration, economic feasibility, procurement and construction schedule, measurement and verification requirements, operation and maintenance considerations; identify barriers and make recommendations to mitigate these barriers;
- b. The CONTRACTOR shall integrate all of the results obtained from Tasks 1 through 3, herein, into a CHP Site Plan to include schematic equipment layout on-site, identifying new and existing equipment, buildings and system tie-points, and identification of major equipment selections. Detailed equipment specifications shall not be prepared. Site plan shall include a discussion and a diagram of the biogas and CHP plant processes and distribution system design and operation.

- Said CHP Site Plan shall be submitted for Technical Review Committee input and ultimate COUNTY approval;
- c. The CONTRACTOR shall provide for Technical Review Committee input and COUNTY approval, a description and work plan for the future tasks required to implement the project, such as financing, preliminary and detailed engineering, equipment testing, equipment installation, project start-up and operation, and ongoing equipment monitoring; and
 - d. The CONTRACTOR shall submit for Technical Review Committee input and COUNTY approval, a draft final economic and strategic feasibility analysis to the COUNTY.

SCS satisfied its obligations under Task 4 and issued its “Interim Report on Task 4: Final Economic and Strategic Feasibility Study,” dated January 2007. A copy of that report can be found in Appendix D.

SCS/County Contract Task 5 (County/DOE Contract Task 6)

SCS/County Task 5 is titled “Draft and Final Report.” The contract requires that SCS complete the following work:

- a. The CONTRACTOR shall submit for COUNTY review and approval a draft final report on the project. The draft report shall include, but not be limited to, an Executive Summary, an account of the CONTRACTOR’s overall efforts in meeting the requirements of this Contract by Task as well as an evaluation of the efforts, and recommendations for follow-up and future activities. The gas analysis, energy baseline report, site plans, the economic and strategic feasibility analysis, and other analyses shall be included as appendices;
- b. Following acceptance of the draft report by the COUNTY, the CONTRACTOR shall provide the COUNTY with two (2) unbound copy of the Final Report, twelve (12) bound copies of the final report; two (2) electronic disk copies of the final report with the text in MS Word for Windows 6.0; two (2) Excel versions of any spreadsheets (s) developed under the project; two (2) electronic version of design and, if appropriate, two (2) copies of instructions and manuals for any relevant software.
- c. Contractor shall provide one (1) copy of the entire final report and all supporting documents in PDF format.

- d. Contractor shall incorporate disclaimer language in the final report as dictated by the grant funding source(s).

SCS is satisfying its Task 5 obligations with this Final Report.

SECTION 3

RECOMMENDATIONS FOR FOLLOW-UP AND FUTURE ACTIVITIES

Parties Involved in Implementation

There are three parties who could have a role in this project -- PMRF, KIUC and the County. PMRF is the energy consumer. PMRF could take responsibility for design, construction and operation of the power plant, or PMRF could assume the role of an energy customer only. If PMRF elects to continue as an energy customer only, then KIUC or the County or a private investor could design, construct and operate the project.

KIUC, being in the energy supply business, is probably the most likely candidate for project ownership, if PMRF elects not to own the project. The least role KIUC would have in the project would be that of a traditional utility, under which KIUC would provide standby power and purchase excess power. As mentioned in prior sections of this report, it may be necessary for PMRF to buy or lease some segments of KIUC power distribution lines, now owned by PMRF, that are located within PMRF.

The County is the owner of the energy resource. The likely role of the County is energy supplier to PMRF or KIUC. The County could bear the cost of wellfield installation as part of their day-to-day landfill operation, or the wellfield could be installed and operated/maintained by the energy purchaser. The County's desire or ability to enter into a sole source landfill gas sale agreement should also be determined. HRS 103D-102(b)(3) might allow the County to proceed with a sole source negotiation. If the County cannot, or desires not to, negotiate with PMRF or KIUC on a sole source basis, then the County must solicit proposals from any interested party using an advertised Request for Proposals.

As a first step in project development, PMRF, KIUC and the County should meet to discuss their potential roles in the project and execute a Memorandum of Understanding (MOU) to govern their agreed-upon relationship.

Work Plan for Future Tasks

The following steps are necessary to implement the project. The presumption has been made in this discussion that PMRF will design, finance, own and operate the facilities associated with the project, or will engage an ESCO to implement the project on their behalf. If PMRF decides to employ an ESCO, then the additional step of selecting an ESCO needs to be added as the first step in the implementation plan. If another entity implements the project, the steps will be substantially the same. The steps are as follows:

- Negotiate a landfill gas sale agreement with the County;

- Negotiate with KIUC to obtain ownership of use of a few KIUC-owned power distribution line segments in the Navy Housing area;
- Design the landfill gas wellfield, the compressor skid, the landfill gas transmission line and the CHP power plant;
- File for and obtain a Hawaii Department of Health air permit for the engines;
- Prepare other environmental documentation;
- Obtain bids for construction;
- Construct the facilities;
- Perform startup and performance testing; and
- Commence commercial operation.

Negotiate a Landfill Gas Sale Agreement

The construction and operation/maintenance costs for the project assume that PMRF will install and operate the landfill gas collection system and compressor skid. The price paid to the County for the landfill gas must take into consideration the fact that PMRF, rather than the County, paid for these facilities. An alternative approach would be for the County to install and operate these facilities, and the price paid by PMRF to the County for the landfill gas would then be expected to be higher.

While compensation to the County could take several forms, the most common forms of compensation in the landfill gas to energy business are:

- The County would be paid on a \$/mmBtu basis, using an agreed-upon \$/mmBtu rate and actual mmBtu consumed (on a monthly basis); or
- The County would be paid on a percent of gross revenue basis (a percentage of the value of the power produced).

The second approach would be more difficult to employ, since the value of the power produced is based on net avoided cost, plus some power sale to KIUC, as compared to 100 percent power sale to KIUC, where the actual value of the power produced would be clearly known.

Negotiate with KIUC on Power Distribution Lines

As discussed in the Interim Report on Task 3, KIUC and PMRF have mixed ownership of the power distribution lines in the Navy Housing area. Most of the power distribution lines are owned by PMRF; however, the power distribution system is incomplete without KIUC's lines.

There are five possible resolutions to this issue:

- KIUC could give the lines to PMRF;
- KIUC could sell the lines to PMRF;
- KIUC could lease the lines to PMRF;
- PMRF could install its own power distribution lines in the “missing” segments; or
- Service to the Navy Housing area could be eliminated from the project.

While elimination of the Navy Housing area will adversely impact project revenues, the impact on the project’s financial viability will not be that great since a \$1.23 million investment in a new power transmission line between the PMRF power plant and the Navy Housing area would be eliminated, and the power not consumed in the Navy Housing area would be sold to KIUC, albeit at a lower value.

During the discussions with KIUC about their power distribution lines in the Navy Housing area, PMRF should inquire as to whether KIUC would be willing to wheel (transmit) power from the PMRF power plant to the Navy Housing area through KIUC’s existing, off-site distribution lines, and at what price KIUC would be willing to provide that service. It may be more cost-effective to pay KIUC for wheeling than to construct a \$1.23 million power transmission line on-site.

Design Landfill Gas to Energy Facilities

The design of the project will be relatively straightforward since:

- With the exception of about 200 feet of pipeline, the landfill gas transmission pipeline is located on property owned by PMRF. The remaining 200 feet is on property owned by the County. The acquisition of rights-of-ways is not an obstacle to be overcome on this project; and
- The CHP power plant will use proven equipment and technologies. There are more than 200 landfill gas fired reciprocating engine power plants in operation in the United States. There are almost 100 landfill gas compressor skids and pipelines in operation in the United States.

The package of design drawings would include: flow sheets; piping and instrumentation diagrams; single line diagrams; site plans; building plans; mechanical equipment plans; piping plans; conduit and cable schedules; electrical equipment plans; conduit routing plans; and control system architecture drawings. Complete equipment and installation specifications would accompany the design drawings.

Obtain Air Permits and Other Environmental Approvals

The principal permit to be obtained for this project is an air permit from the Hawaii Department of Health (HDH). The proposed power plant will be located in an attainment area. As long as the power plant employs Best Available Control Technology (BACT), as is currently proposed, issuance of an air permit should be straightforward. If the power plant is owned by an ESCO, the ESCO would obtain its own permit.

The landfill is not currently large enough to be subject to USEPA's New Source Standards for Municipal Solid Waste Landfills (NSPS). For this reason, installation of a landfill gas collection system is optional, and a backup flare is not being installed. If the landfill becomes subject to NSPS in the future, the County will probably be required by HDH to install a backup flare.

It is believed that the need for an overall environmental review of the project can be satisfied by obtaining a negative declaration or a mitigated negative declaration. An environmental assessment, a brief summary of the project's net environmental impacts, must be prepared to support obtaining such a declaration.

Obtain Bids for Construction

Construction bids would be obtained through a formal, advertised solicitation, if PMRF owns the project, or through a less formal bidding process, if an ESCO owns the project. In either case, construction of the power plant, landfill gas transmission pipeline and compression skid, and the power transmission line improvements could be awarded to a single contractor or multiple contractors.

Construct the Facilities

Construction of the facilities would be undertaken by a contractor or contractors under the inspection of PMRF or the ESCO. Construction of a project of this type and magnitude would take about 12 months.

Startup and Performance Testing

The contractor or contractors would be responsible for achieving full mechanical completion, commissioning and full functional testing of the individual components of the project. PMRF or the ESCO would jointly conduct the performance tests with the constructor or contractors.

Commercial Operation

If the facilities were owned by PMRF, PMRF would probably engage a contractor to operate the facilities. The contract could be a new contract or could be an amendment to the contract PMRF

currently has for operation of the current power plant. It is anticipated that the existing PMRF power plant would remain available to provide standby power. If the operation of the new power plant was combined with the operation of the existing PMRF power plant, it will be possible to achieve some synergy, and perhaps labor cost savings, that were not considered in the costs estimated in this report.

If an ESCO is selected to implement the project, it may be desirable to have the same ESCO assume responsibility for operating the existing PMRF power plant.